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Two-dimensional Fermi Gases

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Pairing of fermions is ubiquitous in nature and it is responsible for a large variety of fascinating phenomena like superconductivity, superfluidity of 3He, the anomalous rotation of neutron stars, and the BEC-BCS crossover in strongly interacting Fermi gases. When confined to two dimensions, interacting many-body systems bear even more subtle effects, many of which lack understanding at a fundamental level. Most striking is the, yet unexplained, effect of high-temperature superconductivity in cuprates, which is intimately related to the two-dimensional geometry of the crystal structure. In particular, the questions how many-body pairing is established at high temperature and whether it precedes superconductivity are crucial to be answered. We report on the observation of pairing in trapped two-dimensional atomic Fermi gas in the regime of strong coupling. We perform momentum-resolved photoemission spectroscopy to measure the spectral function of the gas and we detect a many-body pairing gap above the superfluid transition temperature. Moreover, using the same technique, we investigate spin-imbalanced Fermi gases and find evidence for the formation of polarons and their crossover to a dimer state in two dimensions. Our observations mark a significant step in the emulation of layered two-dimensional strongly correlated superconductors using ultracold atomic gases.